Can Micromegas be used as the UMS for CKM2 ?

- **Micromegas (MICRO MEsh GAseous Structure) are a class of Micro Patterned Gaseous Detectors, which are beginning to gain acceptance in HEP:**

  NA48(micromegas), COMPASS (Gem, micromegas), HERAb (msgc)

- **By clever electric field design, drift ions are removed from the gas volume ~ 10x faster than conventional MPWC**

- **Drift time of ions ~ 100 nsec (compare to many μsec's for MPWC)**

- **Can operate at high rate and has good timing resolution. Low material content.**

- **Very economical and can be mass−produced**

Hogan Feb−4th−2004

Y. Giomataris et al. / Nucl. Instr. and Meth. in Phys. Res. A 376 (1996) 29–35

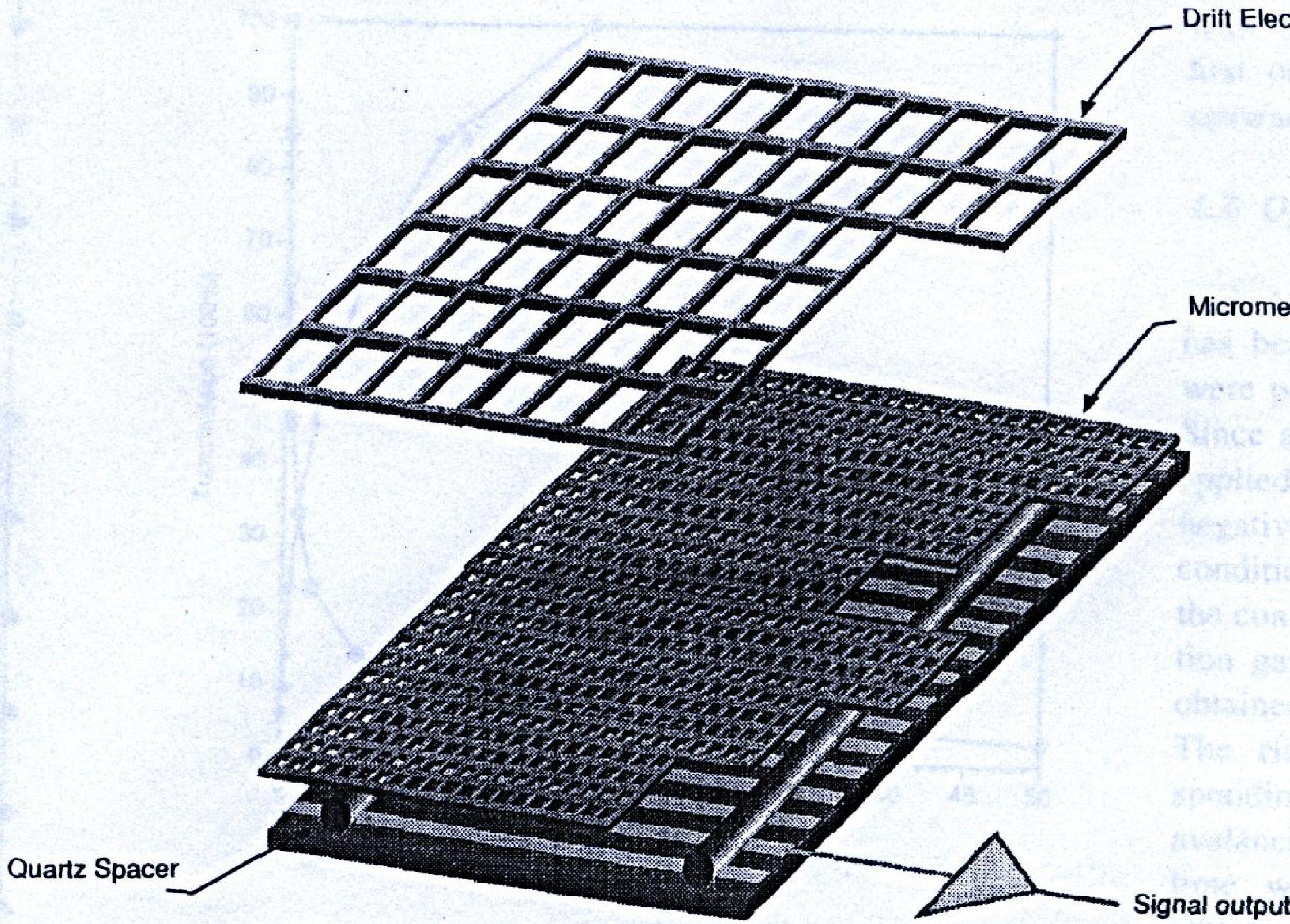


Fig. 3. A three-dimensional view of the detector elements.

μmega structure

2. Detector description

A detailed description of Micromegas is given in Ref. [1]. Our tests were performed with $15 \times 15\,\mathrm{cm}^2$ chambers with a conversion gap of 3 mm, an amplification gap of 100 μm or 50 μm and a strip pitch of 317.5 μm with a spacing of 70 μm. The parallelism between the micromesh grid and the anode is maintained by spacers of 150 μm diameter, every 2 mm. They are printed on a thin epoxy substrate by conventional lithography of a photoresistive film. This is a very cheap and easy process. The standard height of the spacers is 100 μm or 50 μm, but other spacings are possible. A thin Kapton foil can be used instead of epoxy as the substrate in order to reduce matter thickness. By using a thin Kapton foil as the strip substrate the total material will not exceed 10% that of a typical silicon strip detector. Developments in this way have already started.

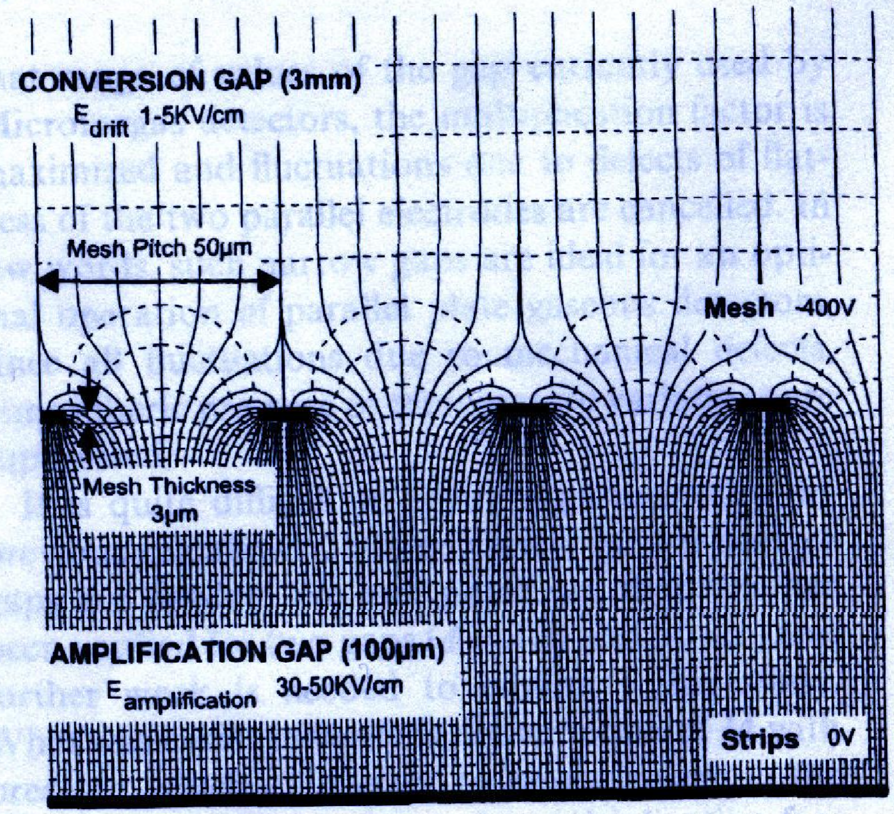


Fig. 1. Micromegas electric field map.

Most of the ions drift O(100 μm), so ion−collection time ~ 100 nsec

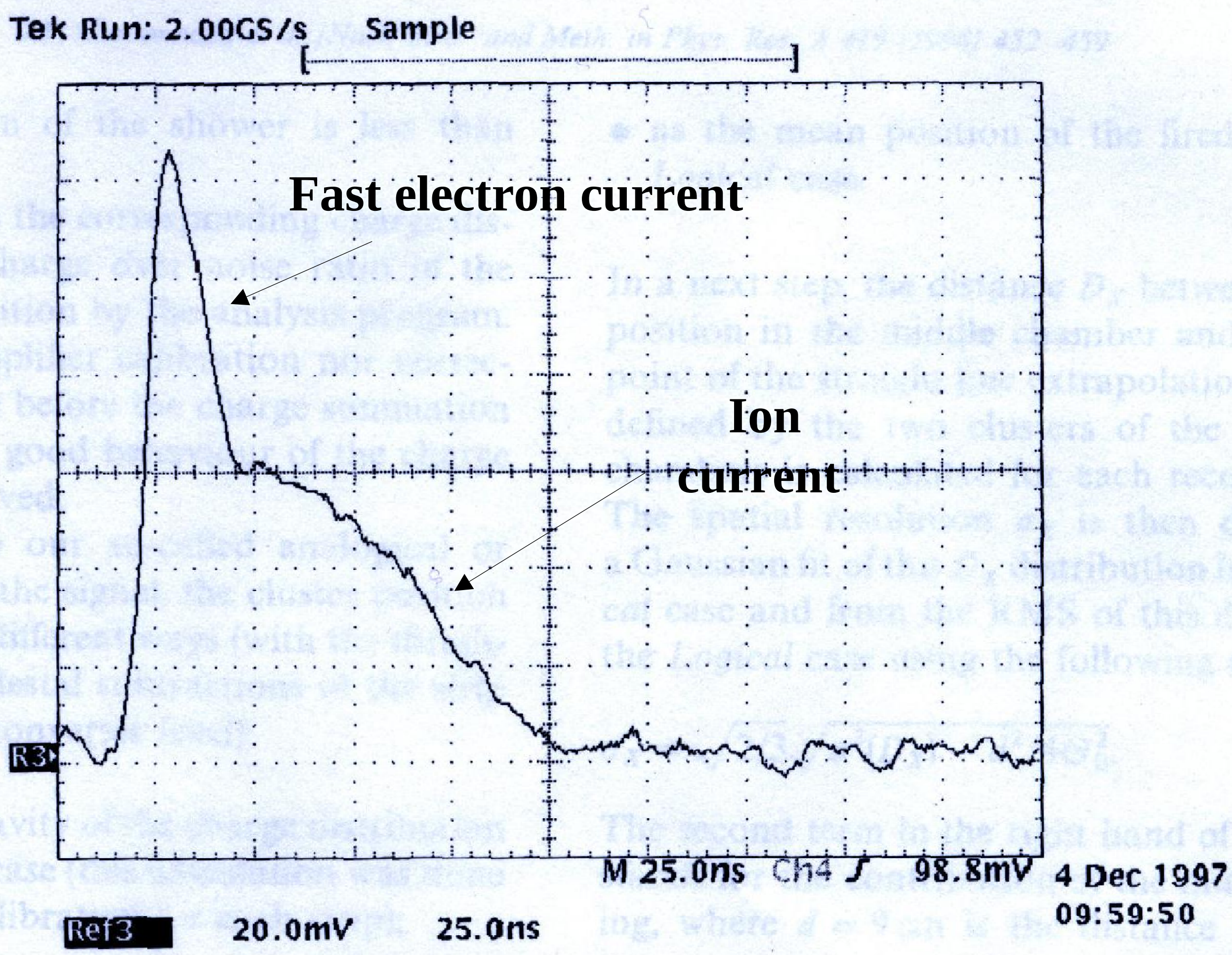
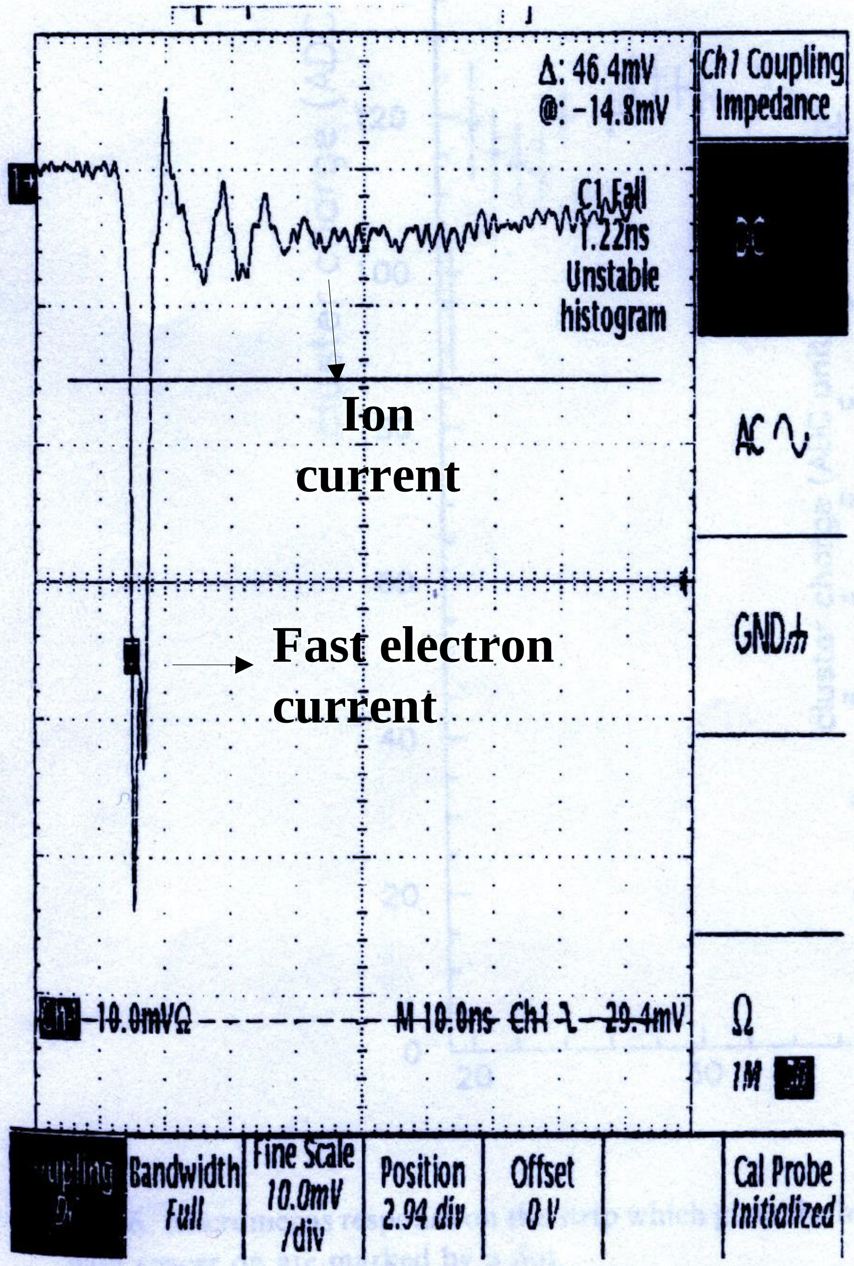


Fig. 3. Strip signal (negative signal) of the ^{55}Fe source obtained through a Lecroy TRA402 preamplifier. The total deposited charge reaches 0.2 pC.



times higher than the ion tail. Such fast signals will allow the development of novel drift chambers or small TPCs with a time resolution of the order of 1 ns.

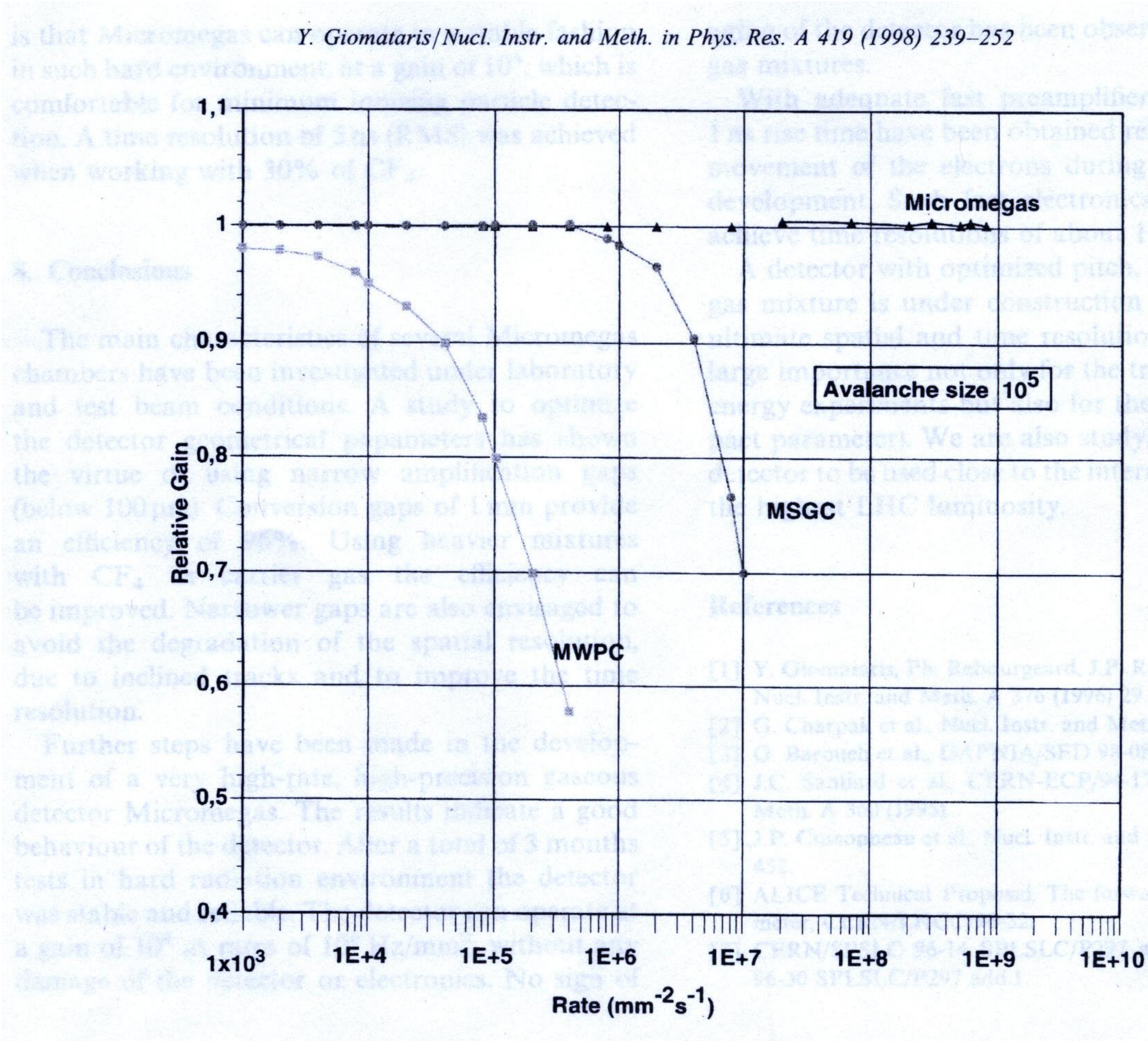
6. Beam tests

Several chambers $15 \times 15\,\mathrm{cm}^2$ were extensively tested in various particle beams. First, tests were performed in the CERN PS beam at a moderate flux. In a second test at the CERN SPS the particle rate was of 2×10^8 per burst of 2 s on an area of $2\,\mathrm{cm}^2$. A detailed description of those tests can be found in Ref. [3].

6.1. *Set-up*

Our first tests of Micromegas were done with a gas filling of argon-isobutane [2]. We pursued with a more standard argon-DME mixture. The amplification gap was 100 μm.

Fig. 5. Signal given by a fast current preamplifier. The rise time of the signal is 870 ps.



Rate of gamma ray (Fe55) absorption

MPGD's have been tested to high rate of gamma ray (Fe55) flux

Max rate for μmegas > 8 x 10^8 gammas absorbed /mm^2/sec

Assuming W = 30 eV (W= effective ionization potential of typical gas),

max rate of electrons incident on μmega surface > **(8 x 10^8) (6000/30) = 1.6 x 10^{11} electrons/mm^2/sec**

For CKM2:

Transverse dimension of beam in achromat

path length of hadrons in UMS gas

rate of electrons incident on μ mega surface = **(300 x 10^6) (94 electrons/cm) (1/8000) = 37.5 x 10^6**

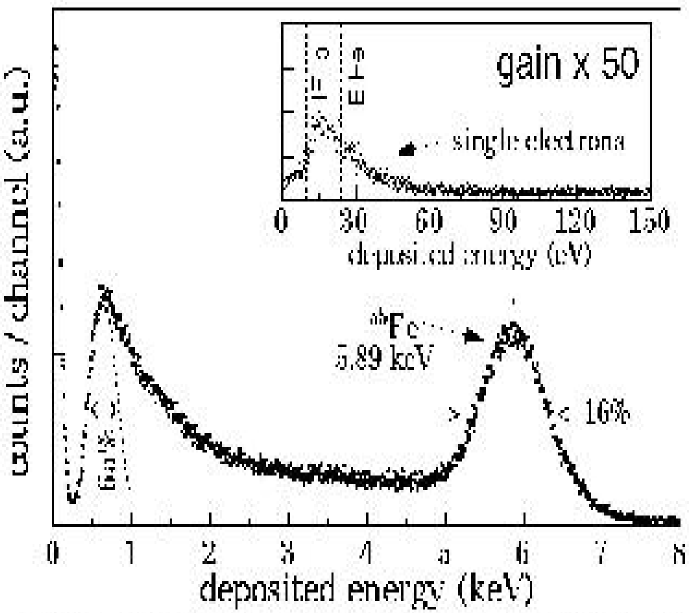


FIG. 1. Response of an unshielded He + 10% iC_4H_{10} μMS chamber ($10 \times 10 \times 1.5$ cm^3 conversion volume) to a weak ^{55}Fe source at 1 bar. The assymetric signal at low energy (present only at non-zero drift field) is presumably due to cosmic muons of $dE/dx \sim 0.4$ keV/cm. *Inset:* Blow-up of the threshold region: the peak at ~20 eV is probably due to single-electron field emission from the nickel micromesh. The frequency of this process (here 10^{-2} Hz) strongly depends on operating conditions and was not optimized during this run. Ionization energies for isobutane and He are indicated, evidencing the good linearity in energy of the device.

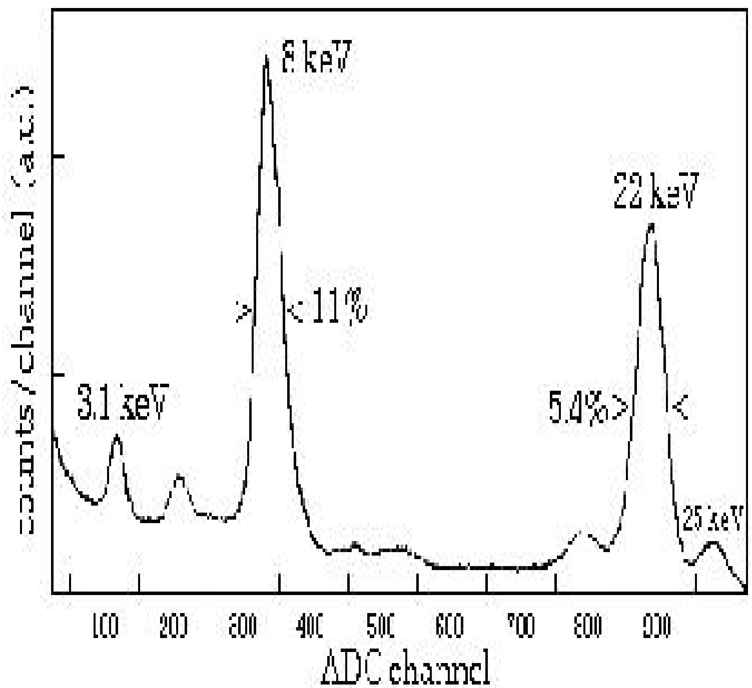
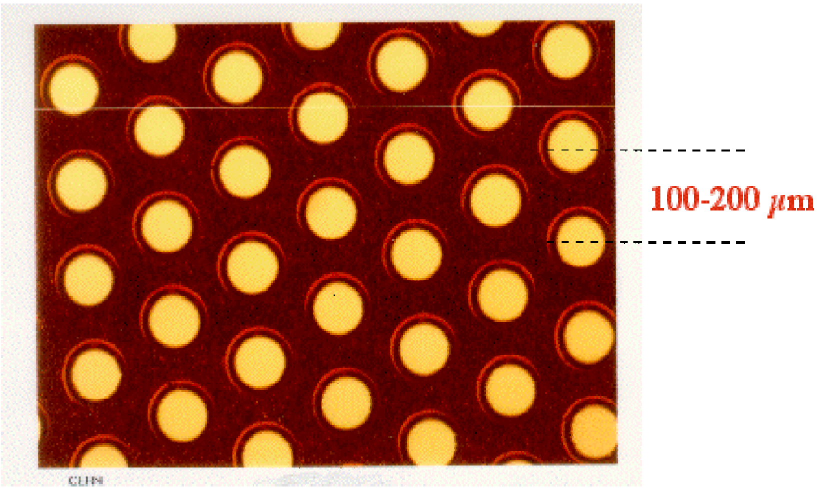
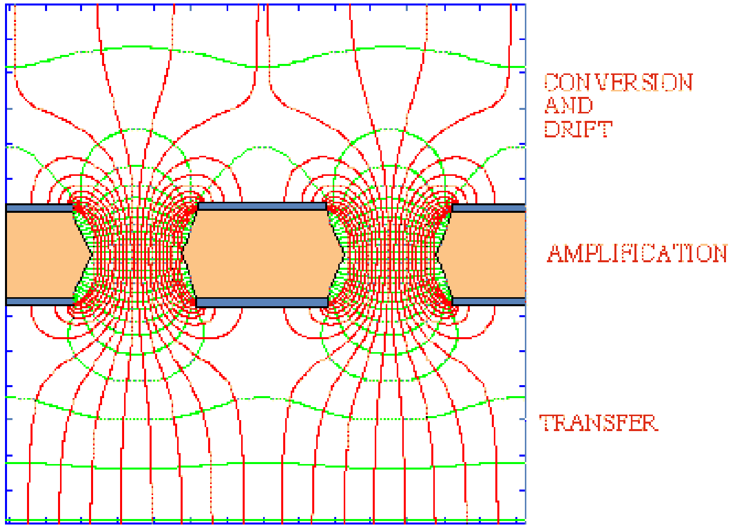


FIG. 2. Response of an Ar + 10% iC_4H_{10} μMS chamber to collimated ^{109}Cd X-rays at 1 bar. The energy resolution is already comparable to that of large Germanium detectors [39].

μmegas also have good energy resolution. An ADC on each strip can flag deposits from more than 1 hadron. This might really help with pattern recognition.

Another alternative: Gas Electron Multiplier (GEM)





• Cu−coated Kapton foil with micropores
• Good rate performance measured up to $5\text{x}10^5$ gammas/mm^2/sec, and could be even better. Rate performance probably not as good as μmegas.
• Gain is controlled by Kapton foil thickness (~100 μm thick)
• One expert opinion: easier to build than μmegas since no need for careful gap control between mesh structure and strip readout structure.

- **μmega seems to be really promising technology**

- **Rate characteristics (and energy resolution) seems promising**

- **Other MPGD detectors to consider: GEM**

- **Received 2 GEM foils from Juan Collar @ UofC**

- **Relatively easy to build. GEMS are easier to build than μmegas.**

- **Small GEM detector can be constructed ~ 1 month**

- **Local Midwest expertise:**

  Juan Collar @ UofC
  Ian Shipsey @ Purdue